POWER *from the* PEOPLE

Burgeoning populations have led to an increase in wastewater and wastewater treatment plants (WWTPs). Treatment facilities are not always popular as neighbors, but they are a necessity—and one with a silver lining. The biogas generated by anaerobic digesters is a valuable source of renewable fuel. In fact, biogas is a more prevalent, more consistently reliable source of renewable energy than either wind or solar power. As treatment plants expand to meet demand, they have an opportunity to maximize the benefits of this unique, renewable resource.

Fuel cells transform wastewater into clean, renewable energy

By Anthony Leo & Christopher Pais

Traditionally, facilities have used piston engines or microturbines to burn the biogas, generating heat and electricity in combined heat and power (CHP) systems. Burning biogas, however, pollutes the air. WWTPs need to consider their "emissions profile" as states and air quality management districts tighten environmental requirements. In many instances, engine-driven systems cannot meet the demanding requirements set to limit the emission of nitrogen oxides (NOx), sulfur oxides (SOx) and particulate matter (PM).

Instead of expanding, some plants face shutdown of their renewable power operation if they cannot comply. How can a wastewater facility improve or maintain its cost savings and renewable fuel incentives while meeting these tough emissions standards?

Fuel cells are uniquely positioned to answer these requirements. They produce power without combustion, turning biogas into clean power with negligible emissions, and qualify for valuable incentives and tax credits. In addition, fuel cells run cleanly and quietly in any location. They can be sited close to urban populations with minimal land use and disruption. In many locations, they are interesting attractions.

California Application

The Dublin San Ramon Services District (DSRSD) in California's Tri-Valley area is one of the latest examples of a WWTP applying the fuel cell solution. Explosive population growth in the region has led to a recent expansion of the Pleasanton WWTP—from 11.5 million gal per day (mgd) to 17 mgd. While planning the expansion, plant managers kept their focus on additional efficiency goals important to the district and its ratepayers. These included a reduction in total energy required to treat wastewater, an increase in distributed generation capabilities and recycling of wastewater for use in the surrounding community.

DSRSD installed two Direct FuelCell DFC300MA power plants, manufactured by FuelCell Energy, Inc., at its regional WWTP. The city's fuel cell power plant is the central component in the efficient operation of its wastewater treatment process. As a byproduct, the fuel cells generate heat that is used to heat sludge, optimizing the anaerobic digestion process that generates biogas. The biogas is then returned to the fuel cell to operate the plant. Located in the heart of the city, surrounded by a residential neighborhood and community athletic fields, these fuel cells provide 600 kW of electricity on a 24/7 basis, with virtually no emissions, a small footprint and low noise levels.

Going 'Green' Means Saving Green

Because fuel cells make energy through a noncombustion process, they produce virtually zero emissions of NOx, SOx and PM. Whether Pleasanton is operating its fuel cells on digester gas, natural gas or any combination of the two, the plant remains classified as an "ultraclean" installation under California law.

The DFC300MA is certified to meet the stringent distributed generation emissions standards established by the California Air Resources Board. Meeting this standard also exempts it from air pollution control and air quality district permitting requirements. Certification qualifies the fuel cell for preferential rate treatment by the California Public Utilities Commission, which includes elimination of additional exit fees and standby charges.

Stringent new regulations will require plants to produce power from biogas as cleanly as from their primary power source. This may cause a scramble at sites using combustion engines and turbines. In fact, the standard may prove difficult to meet at all with some technologies, putting the cost advantages of using biogas energy in jeopardy. Fuel cells are considered one of the best approaches for distributed generation requirements under the new near-zero emissions compliance rules.

California's Self-Generation Incentive Program offers financial incentives to customers who install distributed generation facilities that meet some or all of their own energy requirements. As of Jan. 1, 2008, most internal combustion engines, microturbines and gas turbines no longer qualify for incentives under this program. Fuel cells qualify for all new installations.

Dirty Water In, Clean Power Out

California's Central Valley has seen a dramatic increase in wastewater due to a growth in population and the existence of some of the world's largest dairy operations. Located in the heart of the region, the city of Tulare has upgraded its regional WWTP, roughly doubling its capacity during the last two years. It has also installed FuelCell Energy DFC300MA power plants, providing 24/7 electricity from biogas generated by industrial waste from the area's large food and dairy processing plants.

The DFC300MA is ideally configured in size for WWTP applications. Three such units, with a total capacity of 900 kW of baseload power, were installed at the Tulare facility. In addition to highly efficient generation of electricity from biogas and the ability to reduce the plant's dependence on the local power grid, the fuel cell system also made economical sense.

The Tulare plant's headworks sends 4.4 mgd of wastewater to a bulk volume fermenter (BVF). The BVF separates solid and organic matter from the wastewater, then uses anaerobic processes to convert the organic manner into digester gas, which is water-saturated and at a temperature of about 100°F. At this stage, the raw digester gas can contain as much as 2,500 ppm by volume of hydrogen sulfides (H_2S) and other contaminants.

The gas treatment system receives this gas and completes a series of steps to prepare it for use in the fuel cell. The gas enters a series of water scrubbers and iron sponge media to remove the H_2S. Next, it is compressed to 50 lb-force psig and moved into a heat exchanger. The heat exchanger cools the gas to 40°F to remove most of the water, then reheats it to 65°F. This reheating raises the gas pressure dewpoint, which helps prevent any condensation as the gas is transported from the treatment system to the fuel cell. Finally, the compressed gas enters two contaminant removal vessels, where graphite media is used to remove siloxanes and other emissions of volatile organic compounds.

The fuel cell receives the treated gas and converts it into electricity as it does with pipeline-supplied natural gas. Due to the high temperature at which carbonate fuel cells operate, the fuel is converted to hydrogen within the fuel cell, removing the process of external reforming and its associated costs.

Efficient Cogeneration

As a byproduct of their electrical production, fuel cells generate heat, which is recovered and used to preheat sludge, optimizing anaerobic digestion. The result of this process is biogas, used to fuel the plant.

Some plants can generate up to 50% of electric power needs from digester gas alone, with about twice the electric power generation efficiency of a microturbine. Adding heat recovery to the electrical conversion efficiency results in an overall operating efficiency of more than 70%.

Electricity produced during the cogeneration process has a value several times higher than that of waste heat—a fact underscored by unpredictable price surges for grid-supplied electricity. Therefore, reducing electrical power purchased from the grid can save significantly more money than generating larger quantities of heat for a given application.

Cogeneration with a fuel cell, especially one using biogas, helps shift the power paradigm when considering trade-offs between waste heat and electricity production. Traditional installations using microturbines or reciprocating engines typically focus on putting their copious waste heat to good use. While this approach makes efficient use of waste heat, it also can mask the lower overall efficiency of a motor-driven system when compared to a fuel cell system. Generating less electricity from the system means buying more electricity from the grid—and at higher prices.

Reliable, Responsible Neighbors

Providing clean water is the most important responsibility for a WWTP, but an independent, distributed generation capability can be a close second when conditions turn tough.

Plants with fuel cells have demonstrated this advantage during major power losses, including California heat wave brown-outs in 2006 and 2007 and Sierra snowstorms in 2008. During such challenges, fuel cells can keep a treatment plant up and running, generating power for itself and its community. WWD

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